

## Hyperspectral Microwave Photonic Radiometer, Phase I

Completed Technology Project (2018 - 2019)



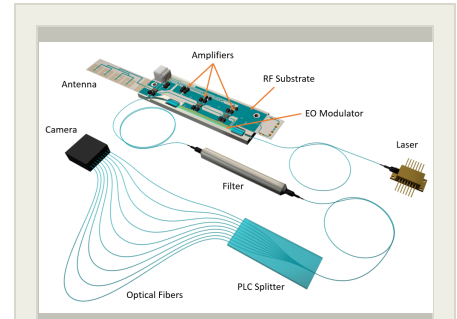
## Project Introduction

Passive Microwave Remote Sensing is currently utilized by NASA, NOAA, and others to conduct Earth Science missions, including weather forecasting, early warning systems, and climate studies. These sensors could also be used in upcoming missions such as Saturn's moon to study atmospheric makeup. On earth, humidity and temperature sounding is conducted near several absorption lines to determine key parameters of the atmospheric state, including moisture content, temperature, and barometric pressure. Using neural networks, these parameters are retrieved from raw sensor data at a small number of discrete frequencies near the absorption lines. To improve retrieval accuracy as well as predictive ability of weather models, a large number of closely spaced frequencies, i.e. hyperspectral sensing should be implemented. Such approach is also helpful in RFI mitigation and sensor calibration. As such, under the current program PSI will develop a hyperspectral microwave photonic radiometer concept capable of acquiring a hundred or more detection frequencies simultaneously on a  $\sim 1$ GHz channel spacing. We leverage microwave photonics to convert the RF signals up to optical frequencies, where they are readily manipulated with low loss and wide bandwidth using optical components. We survey available elements, such as prism, diffraction grating, or arrayed waveguide grating, to implement the dispersive function. Under a previous NOAA Phase II SBIR, PSI delivered a frequency agile microwave radiometer that could be tuned across the entire V-band with  $\sim 1$ K NETD at 2GHz bandwidth and 100msec integration time. This sensor, however, performed measurements in serial fashion by sweeping a local oscillator. Under the proposed effort, we will adapt our existing V-band hardware to perform these spectrally resolved measurements simultaneously. We will demonstrate an 8-channel system with 3 GHz frequency spacing, which can be scaled to larger channel counts in a straightforward manner.

## Anticipated Benefits

The hyperspectral radiometer can be employed in passive sensing of microwave radiation from earth and other celestial bodies for weather data, atmospheric composition and dynamics. Active operation is a straightforward extension for radar applications where range data is useful. Implemented in a phased array, spatially and spectrally resolved signals can be realized, with high gain beam forming readily achieved, an advantage for communications and telemetry applications.

Low attenuation of mmW radiation enables sensors to "see-through" many visual obscurants. Applications include: Marine navigation in dense fog, aircraft landings in adverse weather, emergency response vehicle operation in poor weather or smoke, monitoring highways for traffic safety, surveillance and target acquisition in inclement weather, non-intrusive portal security and stand-off frisking.



Hyperspectral Microwave Photonic Radiometer, Phase I

## Table of Contents

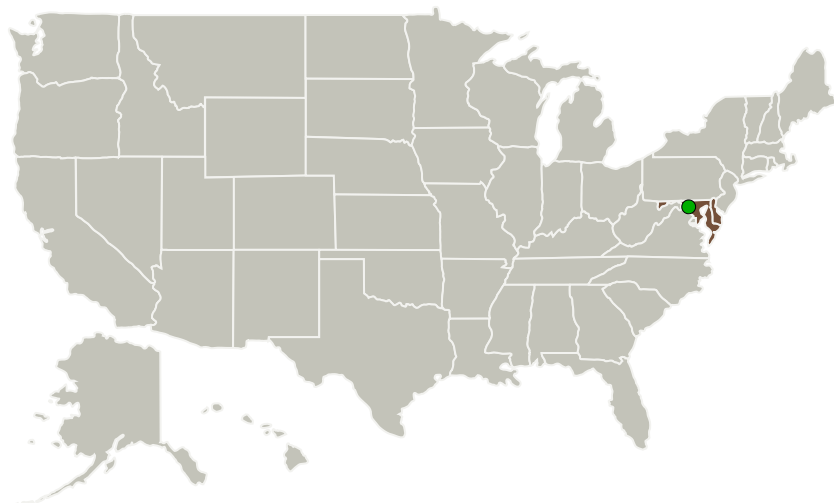
Project Introduction	1
Anticipated Benefits	1
Primary U.S. Work Locations and Key Partners	2
Project Transitions	2
Organizational Responsibility	2
Project Management	2
Technology Maturity (TRL)	2
Images	3
Technology Areas	3
Target Destination	3

## Hyperspectral Microwave Photonic Radiometer, Phase I

Completed Technology Project (2018 - 2019)



## Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Phase Sensitive Innovations Inc.	Lead Organization	Industry Veteran-Owned Small Business (VOSB)	Newark, Delaware
● Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland

## Primary U.S. Work Locations

Delaware	Maryland
----------	----------

## Project Transitions

**July 2018:** Project Start**February 2019:** Closed out**Closeout Documentation:**

- Final Summary Chart(<https://techport.nasa.gov/file/141101>)

## Organizational Responsibility

**Responsible Mission Directorate:**

Space Technology Mission Directorate (STMD)

**Lead Organization:**

Phase Sensitive Innovations Inc.

**Responsible Program:**

Small Business Innovation Research/Small Business Tech Transfer

## Project Management

**Program Director:**

Jason L Kessler

**Program Manager:**

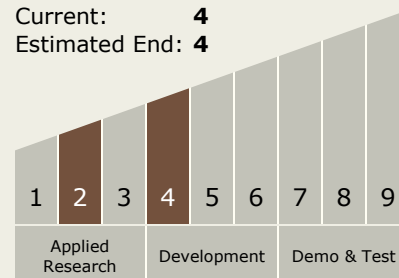
Carlos Torrez

**Principal Investigator:**

Thomas Dillon

## Technology Maturity (TRL)

Start: 2  
Current: 4  
Estimated End: 4

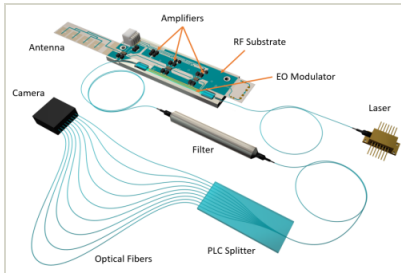


# Hyperspectral Microwave Photonic Radiometer, Phase I

Completed Technology Project (2018 - 2019)

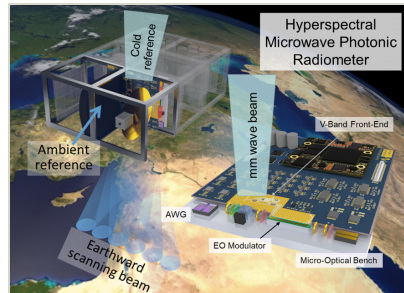


## Images



### Briefing Chart Image

Hyperspectral Microwave Photonic Radiometer, Phase I  
(<https://techport.nasa.gov/image/133115>)



### Final Summary Chart Image

Hyperspectral Microwave Photonic Radiometer, Phase I  
(<https://techport.nasa.gov/image/132321>)

## Technology Areas

### Primary:

- TX08 Sensors and Instruments
  - └ TX08.1 Remote Sensing Instruments/Sensors
    - └ TX08.1.4 Microwave, Millimeter-, and Submillimeter-Waves

## Target Destination

Earth